**SCIENCE COMPETENCIES**

**6/29/11**

**INVESTIGATE**

*Ask a question, formulate a hypothesis, design an appropriate experiment or inquiry, and gather appropriate data to complete the inquiry.*

* + Emerging competency is revealed when students:
    - Demonstrate curiosity about the natural world
    - Ask scientifically testable questions
    - Develop and defend a hypothesis, explain the reasons behind it, and defend or alter the hypothesis based on new information
    - Plan and execute an experiment or scientific investigation that is appropriate to the question
    - Explain and justify how the investigation will test the hypothesis
    - Identify tools and/or resources that can help answer the question
    - Identify and control for variables
    - Perform accurate calculations and relevant statistical tests
    - Locate valid, useful, and up-to-date references to support inquiry
    - Demonstrate proficient library, mathematical and computer skills in data gathering and analysis
    - Observe and measure:
      * Know what to measure and record, in order to clarify and answer scientific questions
      * Apply an understanding of what can be measured, in what ways, and to what extent
      * Select and use appropriate tools observe and measure (directly and indirectly) objects, organisms, and/or events
      * Identify qualitative and quantitative changes in objects, cells, organisms, populations, and ecosystems given conditions (e.g., temperature, mass, volume, time, position, length, quantity) before, during, and after an event
      * Select from and use a variety of appropriate technologies to collect, analyze, record, and display data
      * Attend to the appropriate level of precision

**DEVELOP MODELS, INTERPRETATIONS & EXPLANATIONS**

*Analyze data, design powerful models, and develop insightful conclusions about scientific phenomena, systemic relationships, and the intersection of science and human societies.*

* + Emerging competency is revealed when students:
    - Organize data in ways that facilitate analysis and interpretation (e.g. in charts, graphs, pictorially)
    - Seek and identify valid patterns in data, mindful of outliers and anomalies
    - Choose appropriate tools to aid in data analysis
    - Classify, based on similarities, differences, and interrelationships, to establish order
    - Develop and use models to clarify, illuminate, and/or make sense of phenomena
    - Critique models, indentifying their usefulness and limitations in representing scientific phenomena and relationships
    - Connect single events to the broader context of a system
    - Analyze and explain the effect that a change in one element of a system might have on other elements of the system and on the system as a whole
    - Describe complex societal issues with strong science and technology components from a systems point of view, highlighting how changes in one part of the system are likely to influence other parts of the system
    - Identify the role of science and scientific thinking in world events
    - Identify alternative explanations or solutions, making and defending decisions on which is best
    - Integrate new information and ideas into existing mental frameworks, making adjustments to understanding, as required
    - Explain the limitations of science in explaining world events or solving world problems
    - Explain the ethical issues that are connected with some scientific decisions and make and defend judgments about the best choices
    - Acknowledge and explain controversies within the scientific community, demonstrating an understanding that science advances through ongoing debate, information gathering, and re-interpretation
    - Analyze cause and effect in their broadest senses, attending to distant or subtle causes and distant or unexpected effects
    - Synthesize multiple pieces of evidence and multiple theories to arrive at defensible conclusions
    - Identify and take into account differing perspectives on scientific issues.

**CONSTRUCT SOUND ARGUMENTS**

*Draw and defend conclusions about scientific phenomena, based in logical thinking and powerful and sufficient evidence.*

* + Emerging competency is revealed when students:
    - Distinguish the results of an inquiry from the conclusions that can be drawn from those results
    - Make and defend valid inferences based on trends uncovered in the data
    - Identify and explain the limitations to the conclusions that can be drawn from the data
    - Locate valid, useful, and up-to-date references to support inquiry and inform the development of conclusions
    - Seek and interpret data to develop and support a position on key issues involving science, rather than accepting only the conclusions given by others
    - Respond appropriately to questions and concerns raised by others, adjusting conclusions as required (this overlaps with “Innovate and Adapt”)
    - Identify scientific concepts that must be applied in order to fully interpret world events, explaining the data and analysis that underlie the interpretation

**QUESTION and CRITIQUE CLAIMS**

*Question and critique the work of other scientists (including classmates) and lay people, identifying possible flaws or errors in their procedures, analysis, or application of scientific ideas.*

* + Emerging competency is revealed when students:
    - Evaluate the design of a scientific investigation
    - Critique research presented by others, analyzing whether evidence (data) and scientific principles support proposed explanations
    - Recognize flaws in scientific claims, such as uncontrolled variables, overgeneralizations from limited data, and experimenter bias
    - Offer and defend alternative interpretations of scientific phenomenon
    - Compare various theories that could explain a phenomenon, giving clear and accurate reasons, based on data and logical inference, for preferring one over the other
    - Evaluate a given source for its scientific credibility (e.g. web sites, product advertisements, use of personal testimony in place of scientific evidence, etc.)
    - Challenge conclusions that are claimed to be based in science but, instead, are influenced by tradition, superstition, authority, doctrine, bias, or intuition
    - Critically evaluate scientific reports or accounts presented in the popular media, understand the basic scientific facts related to important contemporary issues (e.g., global warming, genetically modified foods), and ask informed questions about those issues
    - Evaluate explanations proposed by examining and comparing evidence, pointing out statements that go beyond evidence, and suggesting alternative explanations

**INNOVATE AND ADAPT**

*Develop novel ideas and approaches to scientific inquiry and respond to expected and unexpected challenges.*

* Emerging competency is revealed when students:
* See phenomena in a new way
* Apply new techniques of observation, measurement, recording, or analyzing
* Find a more efficient or effective way to investigate
* Refocus a broad or ill-defined question upon independent realization or feedback from others
  + - Respond thoughtfully and effectively to questions about possible errors or alternative conclusions
    - Use conclusions to confirm or refute the original hypotheses, defending reasoning
    - Apply inferences and predictions gained from the data to ask and answer new questions

**WORK STRATEGICALLY**

*Make and act on deliberate choices about what to do, when and how to do it, and how best to negotiate challenges along the way.*

* Emerging competency is revealed when students:
* Develop an experimental “plan of action” that is likely to yield the results sought
* Predict likely challenges or errors and make adjustments to avoid or overcome them
* Consider and explain various possible paths to achieving a scientific goal, defending the choice of which path to pursue
* Identify and prioritize questions to answer, steps to take, resources to consult
* Rethink approaches based on new information gained new ideas raised
* Use time and resources effectively
* Create and use opportunities to build upon personal strengths and minimize weaknesses in order to achieve goals
* Develop, implement, and adjust processes and procedures to enhance effectiveness
* Develop and enhance relationships that foster productiveness
* Extend procedures, strategies, and ideas that work in one situation to other situations, to maximize productivity
* Identify new learning that is required and devise ways to gain it

**COMMUNICATE**

*Communicate scientific information and ideas clearly and effectively, adjusting to address different audiences and purposes.*

* + Emerging competency is revealed when students:
    - Use accurate scientific language to communicate information and ideas
    - Communicate and defend a scientific argument
    - Defend scientific conclusions persuasively, providing detail on the information and the thinking that resulted in the conclusions
    - Employ a variety of media for sharing scientific information and ideas, including written prose, oral presentations, interactive discussions, visual media, and digital media
    - Choose structures for communication based on the purpose of that communication (e.g. a lab report to share experimental results and conclusions, an illustrated text to explain a scientific phenomenon, an illustrated oral presentation to persuade an audience to take action on an issue)
    - Adjust vocabulary, emphasis, and level of detail to address the knowledge-level, interests, and openness of various audiences
    - Share results of an investigation in sufficient detail so that data may be combined with data from other investigations and analyzed further
    - Respond to questions and challenges, defending the scientific thinking that resulted in conclusions or adjusting that thinking to reflect new ideas
    - Engage in scientific discourse, building both personal and shared understanding
    - Create and explain charts, graphs, maps, and other visual representations to illustrate processes, connections, and relationships

**CONTRIBUTE**

*Work effectively as an individual, a member of a team, and a member of society to build scientific communities that support a shared commitment to excellence in inquiry, analysis, interpretation, and communication; and to build a better society.*

* + Emerging competency is revealed when students:
    - Balance independence and teamwork
    - Make sound decisions about when to hold their ground and when to compromise for the consensus of the group
    - Work effectively with others to carry out experiments and other investigations
    - Engage in collaborative discussions designed to build and extend scientific understanding
    - Provide feedback to peers, based in a shared understanding of scientific principles
    - Divide work among team members based on an understanding of the task at hand, as well as an appreciation of the skills, interests, and needs of each team member
    - Identify their own interests, strengths, and weaknesses and balance them when choosing roles in group work
    - Facilitate the work of team members
    - Build a shared sense of responsibility and initiative
    - Assert their own ideas and challenge the ideas of others, while demonstrating respect for the ideas and personalities of others
    - Inspire others to work more intelligently, efficiently, and purposefully
    - Identify and clarify issues where scientists or citizens need to make ethical and scientific judgments, and explain why these judgments are necessary, what their personal judgment would be in each situation, and what the implications would be for the approach they would take
    - Make and defend informed choices as an individual and as a member of society about the use of resources, reflecting an understanding of local and global environmental issues, as well as of our interdependent world
    - As a consumer, make decisions and take action that reflect an accurate appraisal of the value of scientific information provided to support that product

**SELF-ASSESS and SELF-ADJUST**

*Pro-actively seek feedback, assess progress and performance all along the way, and make timely and appropriate adjustments, based on gaps between goals and results.*

* + Emerging competency is revealed when students:
    - Accurately assess the quality of the work they produce against classroom and professional scientific standards
    - Take the initiative to get feedback, seek advice, or obtain a different point of view on scientific inquiry in progress
    - Regularly scrutinize their findings and design to ensure that there is sufficient control of variables and of error in their design
    - Revise their work to address self-identified weaknesses
    - Recognize a lack of knowledge, skill or understanding on their own and take the initiative to rectify the situation
    - Stop blaming the equipment, their peers, or their teacher for problems that they could have diagnosed and addressed